EXPRESS MAIL LABEL NO.:
ER16740838US

WHAT IS CLAIMED IS:

1. An optical device that compensates for polarization mode dispersion (PMD) of an optical signal, comprising;

a first rotating device that rotates the polarization angle of the optical signal in a frequency-dependent manner; and

a first-order PMD compensator that receives the rotated signal and compensates for first-order PMD; and

a second rotating device that receives the compensated signal and rotates the polarization angle of the compensated signal in a frequency-dependent manner to compensate for higher-order PMD.

2. The optical device of claim 1, wherein the first rotating device and the second rotating device use substantially the same components.

3. The optical device of claim 2, wherein the first rotating device performs a transform $\mathbf{R}(\omega\mathbf{K})$ and also performs a transform $\mathbf{R}^{-1}(\omega\mathbf{K})$, wherein $\mathbf{R}$ is an operator whose effect is equivalent to rotation in Stokes space, ω denotes the deviation from a central angular frequency of the optical signal and $\mathbf{K}$ relates to a variable delay.

4. The optical device of claim 1, wherein the first rotating device performs a transform $\mathbf{R}(\omega\mathbf{K})$ and the second rotating device performs a transform $\mathbf{R}^{-1}(\omega\mathbf{K})$, wherein $\mathbf{R}$ is an operator whose effect is equivalent to rotation in Stokes space, ω denotes the deviation from a central angular frequency of the optical signal and $\mathbf{K}$ relates to a variable delay.

5. The optical device of claim 1, wherein the first rotating device comprises a second polarization rotator, an interferometer and a third polarization rotator.

6. The optical device of claim 1, wherein the optical device is adjusted such that the polarization at the center frequency of the optical signal is substantially not changed.

7. The optical device of claim 1, wherein the optical device has two adjustable delays.

8. The optical device of claim 1, wherein passing an optical signal through the first rotation device in a forward direction causes a first transformation $\mathbf{R}(\omega\mathbf{K})$ of the optical signal and passing the optical signal in a backward direction causes a second

EXPRESS MAIL LABEL NO.: ER 167408338US

transformation $\mathbf{R}^{-1}(\omega\mathbf{K})$, wherein ω denotes the deviation from a central angular frequency of the optical signal and $\mathbf{K}$ relates to a variable delay.

9. The optical device of claim 1, wherein a transform is performed according to the equation:

$$\mathbf{M}(\omega) = \mathbf{R}(\theta)\mathbf{R}(\omega\mathbf{K})\begin{bmatrix} \exp(i\omega\tau/2) & 0 \\ 0 & \exp(-i\omega\tau/2) \end{bmatrix}\mathbf{R}^{-1}(\omega\mathbf{K}),$$

wherein $\mathbf{R}$ is an operator whose effect is equivalent to rotation in Stokes space, its argument (θ or $\omega\mathbf{K}$ in the equation above) is a three-dimensional rotation vector whose direction is the axis of rotation in Stokes space and whose angle is the angle of rotation. ω denotes the deviation from a central angular frequency of the optical signal, K (the magnitude of $\mathbf{K}$) and τ relate to adjustable delays.

10. In an optical device that compensates for polarization mode dispersion (PMD), a method for adjusting the optical device, comprising:

adjusting a group delay device; and

adjusting a device that performs a frequency-dependent polarization rotation in Stokes space.

11. The method of claim 10, wherein the group delay device is used to substantially compensate for first-order PMD, and the device that performs frequency-dependent polarization rotation is used to compensate for higher-order PMD.

12. The method of claim 10, wherein the group delay device includes at least a first adjustable frequency-independent rotating device and a delay τ.

13. The method of claim 10, wherein the device that performs the first and last frequency-dependent polarization rotation includes at least a second and third adjustable frequency -independent rotating devices and a delay K.

14. The method of claim 10, wherein the optical device is adjusted such that the polarization at a center frequency of an optical signal is substantially not changed.

15. A method for compensating for polarization mode dispersion (PMD) of an optical signal, comprising;

first rotating a first polarization angle of the optical signal in a frequency-independent manner to generate an intermediate optical signal; and

second rotating a second polarization angle of the intermediate optical signal in a frequency-dependent manner to compensate for higher-order PMD.

16. The method of claim 15, further comprising compensating the intermediate optical signal for first-order PMD of the intermediate optical signal before second rotating.

17. The method of claim 16, wherein compensating the intermediate optical signal comprises:

splitting the intermediate optical signal into a plurality of portions;

delaying at least one of the portions; and

combining the at least one delayed portion with at least a second portion of the plurality of portions.

18. The method of claim 15, wherein first rotating and second rotating is performed by a single polarization rotation device.

19. The method of claim 15, wherein first rotating causes a first transformation $\mathbf{R}(\omega\mathbf{K})$ of the optical signal and second rotating causes a second transformation $\mathbf{R}^{-1}(\omega\mathbf{K})$, wherein ω denotes the deviation from a central angular frequency of the optical signal and $\mathbf{K}$ relates to a variable delay.

20. The method of claim 15, wherein $\mathbf{R}$ is an operator whose effect is equivalent to rotation in Stokes space.

21. The method of claim 15, wherein performing the first rotating comprises at least performing a polarization state rotation of an angle θ about the axis defined by the frequency-independent polarization controllers, causing an interference of the optical signal and performing a second polarization state rotation by an angle $-\theta$ around the same axis.

22. The method of claim 15, wherein a transform is performed according to the equation:

$$\mathbf{M}(\omega) = \mathbf{R}(\theta)\mathbf{R}(\omega\mathbf{K})\begin{bmatrix} \exp(i\omega\tau/2) & 0 \\ 0 & \exp(-i\omega\tau/2) \end{bmatrix}\mathbf{R}^{-1}(\omega\mathbf{K}),$$

wherein $\mathbf{R}$ is an operator whose effect is equivalent to rotation in Stokes space, its argument (θ or $\omega\mathbf{K}$ in the equation above) is a three-dimensional rotation vector whose direction is the axis of rotation in Stokes space and whose angle is the angle of rotation, ω

denotes the deviation from a central angular frequency of the optical signal, and **K** and τ relate to adjustable delays.